

## **Experimental Generation of Volcanic Lightning**

Corrado Cimarelli, Miguel A. Alatorre-Ibarguengoitia, Ulrich Kueppers, Bettina Scheu, Donald B. Dingwell

Department of Earth and Environmental Sciences, Ludwig-Maximilians-Universitaet Muenchen, Munich, Germany

E-mail: cimarelli@min.uni-muenchen.de

The large explosive volcanic eruptions that are responsible for injecting large quantities of gas and pyroclasts into our atmosphere, are often associated with intense electrical activity. Their explosive nature means that direct measurement of the electric field close to the vent, (where initial electric activity in the volcanic plume is typically observed), is severely impeded, limiting progress in its investigation. We have achieved volcanic lightning in the laboratory during rapid decompression experiments of gas-particle mixtures under controlled conditions. We have recorded the lightning phenomenon with the observation of electrical discharges using a) a high-speed camera and b) two antennas.

Lightning at the volcanic vent is controlled by the dynamics of the particle-laden jet and by the grain size of the particles. Two main conditions are required to generate the lightning: 1) electrification of particles and 2) clustering of particles driven by the jet fluid dynamics. The relative movement of clusters of charged particles within the plume generates the gradient in electrical potential which is necessary for lightning. In this manner it is the gas-particle dynamics together with the evolving particle-density distribution within different regions of the plume that emerge as the key variables in volcanic lightning. A proportionality between fine ash content of the jet and number of lightning strikes is also evident in our experiments. This first recorded experimental generation of volcanic lightning means that rapid progress can now be expected (under controlled laboratory conditions) in understanding electrical phenomena produced during explosive volcanic eruptions. This in turn may aid the development of lightning monitoring systems for the forecasting of volcanic ash emissions into our atmosphere.